**PCT** WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : A61J 5 /01 — A2

(11) International Publication Number: **WO 98/38964**

(43) International Publication Date: 11 September 1998 (11.09.98)

(21) International Application Number: PCT/GB98/00713

(22) International Filing Date: 5 March 1998 (05.03.98)

(30) Priority Data:
9704586.8 5 March 1997 (05.03.97) GB

(71) Applicant *(for all designated States except US)*: THE DOYLE FAMILY TRUST [GB/GB]; 4 Artillery Place, Mepham Crescent, Harrow, Middlesex HA3 6QJ (GB).

(72) Inventor; and

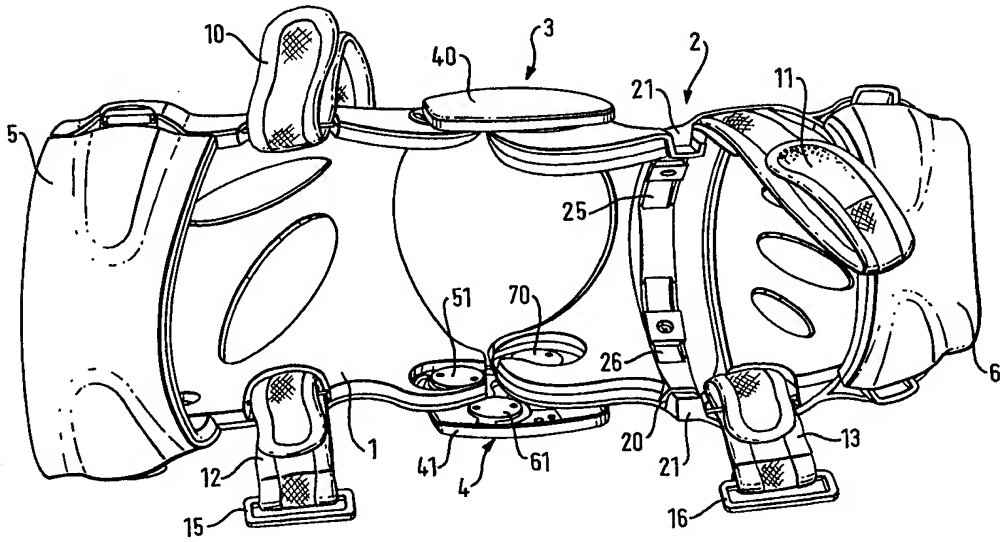
(75) Inventor/Applicant *(for US only)*: DOYLE, Kelvin, Conrad [GB/GB]; 4 Artillery Place, Mepham Crescent, Harrow, Middlesex HA3 6QJ (GB).

(74) Agent: GALLAFENT & CO.; 9 Staple Inn, London WC1V 7QH (GB).

(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

**Published**
*Without international search report and to be republished upon receipt of that report.*

(54) Title: HINGE MECHANISM FOR A LIMB PROTECTOR




(57) Abstract

Hinge mechanisms (3, 4) are described for connecting together the portions of a limb protector such as a knee brace which need to rotate relative to one another when the limb is flexed. The portions (1, 2) are fitted either side of a joint such as a knee or elbow. Each hinge mechanism has a base (41) on which is a restricted range swivel arm. One of the support members (1) is pivotally connected to the base (51) and the other is pivotally connected (70) to the swivelling end of the arm which is itself pivoted (61) to the base (41). Such a hinge construction is compact and effective and lends itself well to adjustment to the degree of movement permitted to the wearer of the device, conveniently by means of packing pieces restricting the relative rotational movements about the three pivots (51, 61, 70).

*FOR THE PURPOSES OF INFORMATION ONLY*

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **AL** | Albania | **ES** | Spain | **LS** | Lesotho | **SI** | Slovenia |
| **AM** | Armenia | **FI** | Finland | **LT** | Lithuania | **SK** | Slovakia |
| **AT** | Austria | **FR** | France | **LU** | Luxembourg | **SN** | Senegal |
| **AU** | Australia | **GA** | Gabon | **LV** | Latvia | **SZ** | Swaziland |
| **AZ** | Azerbaijan | **GB** | United Kingdom | **MC** | Monaco | **TD** | Chad |
| **BA** | Bosnia and Herzegovina | **GE** | Georgia | **MD** | Republic of Moldova | **TG** | Togo |
| **BB** | Barbados | **GH** | Ghana | **MG** | Madagascar | **TJ** | Tajikistan |
| **BE** | Belgium | **GN** | Guinea | **MK** | The former Yugoslav Republic of Macedonia | **TM** | Turkmenistan |
| **BF** | Burkina Faso | **GR** | Greece | | | **TR** | Turkey |
| **BG** | Bulgaria | **HU** | Hungary | **ML** | Mali | **TT** | Trinidad and Tobago |
| **BJ** | Benin | **IE** | Ireland | **MN** | Mongolia | **UA** | Ukraine |
| **BR** | Brazil | **IL** | Israel | **MR** | Mauritania | **UG** | Uganda |
| **BY** | Belarus | **IS** | Iceland | **MW** | Malawi | **US** | United States of America |
| **CA** | Canada | **IT** | Italy | **MX** | Mexico | **UZ** | Uzbekistan |
| **CF** | Central African Republic | **JP** | Japan | **NE** | Niger | **VN** | Viet Nam |
| **CG** | Congo | **KE** | Kenya | **NL** | Netherlands | **YU** | Yugoslavia |
| **CH** | Switzerland | **KG** | Kyrgyzstan | **NO** | Norway | **ZW** | Zimbabwe |
| **CI** | Côte d'Ivoire | **KP** | Democratic People's Republic of Korea | **NZ** | New Zealand | | |
| **CM** | Cameroon | | | **PL** | Poland | | |
| **CN** | China | **KR** | Republic of Korea | **PT** | Portugal | | |
| **CU** | Cuba | **KZ** | Kazakstan | **RO** | Romania | | |
| **CZ** | Czech Republic | **LC** | Saint Lucia | **RU** | Russian Federation | | |
| **DE** | Germany | **LI** | Liechtenstein | **SD** | Sudan | | |
| **DK** | Denmark | **LK** | Sri Lanka | **SE** | Sweden | | |
| **EE** | Estonia | **LR** | Liberia | **SG** | Singapore | | |

# HINGE MECHANISM FOR A LIMB PROTECTOR

This invention relates to a hinge mechanism for a limb protector, particularly for a limb protector for the joint of a human limb, that is a knee or elbow protector. Such items are commonly known as knee or elbow braces.

Injuries to limbs and their joints occur for several reasons, including participation in contact sports such as American football or ice hockey, in individual sports such as skiing or motorcycle racing, or indeed in any active sport. In addition injuries to limbs and their joints occur in active occupations such as the armed forces, or in any type of accident.

After an injury occurs, it is often desirable to either slightly restrict the movement of the limb or joint, for example by elastic supports, or severely restrict movement of the limb or joint by rigid splints, or rigid braces that restrict the degree of movement of the limb or joint, for example by hinged knee or elbow braces (de-rotational braces). Such braces which are available to prevent twisting of a knee or elbow can be worn during

activities such as skiing and can have preventative as well as protective effect. Such hinged braces are by their very nature restrictive of movement and permit only forward bending of the knee or elbow. Other braces are available for sports such as American football which protect the knee against side impact or frontal impact but also restrict movement (prophylactic or preventative braces). Dynamic braces are also available with eccentrically placed hinges to provide protection to torn ligaments. The present invention relates to rigid hinged braces.

WO 94/18916 discloses a variety of hinged braces to be worn for the protection or support of a damaged, or potentially damageable joint. The braces disclosed have, when applied to a knee joint, respective upper and lower rigid supports which engage the leg above and below the knee and which are hinged one to the other to allow bending of the joint. Because of the way the joints of a human being are physically constructed the bending of a joint can occur around any point within a given area covering that joint when that joint is viewed from the side, or in a direction substantially parallel to the axis of rotation of the joint. The exact point about which the joint rotates is dependent upon the construction of the joint, any injuries sustained by the joint or the limb either side of the joint, or the amount by which the limb, and hence the joint has already been bent. When for example the joint being rotated is the knee, the points about which rotation may occur may be either side of the cartilage that separates the tibia and fibula bones on the one side, and the femur on the other side of the knee joint or on both sides of that cartilage. Accordingly, to hinge the upper and lower

supports together about a simple pivot is unsatisfactory. Instead, in preferred constructions as shown in Figures 5 and 16 of WO 94/18916, each is pivoted to an intermediate member and the two intermediate members are pivoted to one another. This allows the axis of rotation to vary relative to the joint, e.g. when moving from standing vertically to bending one's knees.

The constructions shown in WO 94/18916 are cumbersome, complex to assemble, and require the manufacture of a plurality of telescopic shells which must slide over one another easily, but which must be sufficiently rigid and impact-resistant (as such braces are often worn during contact sport play to enable play to occur, but reducing the risk of further injury to a recovering limb) to ensure that such movement can be maintained without jamming. These criteria are not easy to meet.

I have now found that a much more effective and robust hinging mechanism can be provided which maintains the flexibility of movement provided by the constructions shown in WO 94/18916, but which does not incur its disadvantages. In particular, it may enable easy assembly and disassembly and is very resistant to mechanical damage.

According to the present invention there is provided a hinge mechanism for a limb protector including first and second supports each adapted to engage a part of a limb in either side of an articulated joint, the hinge mechanism being pivotally connected to both supports, and wherein the hinge mechanism comprises a base plate, an arm pivotally rotatable against the plate about an axis substantially perpendicular thereto and located to one

end of the arm, and means for connecting the support members pivotally to the other end of the arm and to the plate, all of the three axes of rotation of the pivotal connections being substantially parallel, and wherein associated with each of the three pivotal connections are means for restricting the relative degree of rotation of the respective two members to a defined amount.

Preferably, the arm is mounted rotationally on a circular boss on the plate and the plate has stop means formed thereon restricting the angular rotation of the arm, e.g. to a maximum of 60°.

Preferably, the angular rotation of each support member relative to the end of the arm or the base plate respectively is restricted by the passage of a stud or post along an arcuate slot centred on the pivot axis. The post is conveniently on the base or arm and the arcuate slot in the support member. The extent of the arcuate slot may vary, but is commonly in the range of 50 to 110°.

By hinging of the supports together using a hinge mechanism according to the present invention, with all three pivots having a restricted degree of rotation, the degree of rotation of each of the first, second and third pivotal connections may be set to predetermine the maximum translational and rotational movement between the bones of the joint around which the brace is to be fixed. This may be achieved by providing slots of lengths corresponding to the maximum likely desired degree of pivotal movement, e.g. 60° and 90°, and then limiting the degree of rotation of either or both slots by inserting into the arcuate slot spacers or other means of

preventing rotation, so that the relevant studs or posts may move only along a portion of that slot.

The degree of rotation available to the arm may be limited by locating the arm in a recessed portion of the plate which is bounded by radial walls e.g. inclined at 60° to one another. To limit the degree of rotation further spacers or other means of preventing rotation may be fixed within the recess. In place of a recess with walls, the amount of rotation of the arm may be defined by studs mounted on the plate.

The hinge mechanism of the present invention may be made of any suitable material, preferably aluminium alloy, though, if desired, suitable engineering plastics materials may be used. The support members are conventionally made of rigid plastics or fibre reinforced resin type compositions. In order to avoid over-stressing such materials where they are connected to the hinge mechanism, reinforcements, e.g. of metal, may be installed. In particular, it is found useful to reinforce the edges of the arcuate slots with a metal plate or liner.

In use, each limb protector or brace would have a hinge mechanism according to the present invention on either side of the joint around which the brace was placed.

The hinge of the present invention may be employed on all currently known types of knee brace once suitable modification has been made to those knee braces. In particular, the present invention is of value applied to braces as described in WO94/18916, with the arrangement as described above replacing the front plates of the

hinged brace described therein.

The invention is illustrated by way of example with reference to the accompanying drawings in which:

Figure 1 shows a perspective view of a knee brace incorporating a hinge mechanism according to the present invention, and

Figure 2 shows a detail of the brace of Figure 1 in exploded view.

Referring to Figure 1, the knee brace which is illustrated lying on its side and from the back as shown in the drawing, consists basically of upper and lower hollow shell members 1 and 2 respectively shaped to accommodate the thigh and calf of the wearer. Members 1 and 2 are joined by hinge mechanisms 3 and 4, described in more detail below, and may be held on the respective parts of the leg by means of hard moulded semi-cylindrical portions 5 and 6. Projecting from the ends of portions 5 and 6 are locating tabs and straps which fit into corresponding apertures in members 1 and 2 via appropriate snap action catches enabling each to be pushed towards the member 1 or 2 respectively to fit snugly around the thigh or calf respectively. Substantially the whole of the interior of members 1, 2, 5 and 6 is lined with a cushioning foam for comfort. Fitted to the interior of each of members 1 and 2 are some short metal rods which are substantially vertical when the brace is worn with the wearer standing upright. These are obscured in the drawing by double-sided burr fastener straps 10, 11, 12 and 13. Straps 12 and 13 are relatively short and one end of each terminates in an

elongate plastics ring 15 and 16 respectively through which the free end of the rather longer straps 10 and 11 may be passed and then folded back on itself to tension each strap round the rear of the lower thigh and upper calf respectively. The central portions of the longer straps 10 and 11 may be fabric faced rather than faced with burr fastener material, for greater comfort.

Hollow shell member 2 is constructed in two parts, the left hand one of which as shown in the drawing has an annular outward facing groove 20 and the other portion of which to the right in Figure 1 has an annular inward facing rib 21. Rib 21 can slide in the annular groove to a certain extent, thus allowing a limited degree of swivelling between the portion of the brace which is attached to the thigh and the portion which is attached to the calf. This swivel feature is described in more detail in Specification WO 94/18916. The right hand portion of member 2 is held captive in the left hand portion by means of a pair of squat T-section bosses which pass through two short slots 25 and 26 located in the base of groove 20.

In accordance with the invention, members 1 and 2 are held together by the two hinged mechanisms 3 and 4. Each of hinge mechanisms 3 and 4 consists of a base plate 40, 41 respectively which is pivotally attached directly to member 1 and which has mounted on it a swivellable arm to the free end of which is pivotally attached member 2.

The detailed construction of hinge mechanism 4 is shown in Figure 2. The construction of hinge mechanism 3 is identical save for being a mirror image of hinge mechanism 4.

Referring now to Figure 2, this shows an exploded view of the hinge mechanism with the two members 1 and 2 detached from the base plate 41 and the arm contained therein, for clarity of explanation.

Base plate 41 has two threaded bosses on its surface facing hinge mechanism 3. One of these, denoted 50 in Figure 2, acts as the pivotal connection between base plate 41 and member 1. For this purpose, a lockable threaded stud 51 may be passed through an aperture 52 in member 1 and screwed into boss 50 which is internally threaded. As that occurs, an upstanding arcuate tab 54 enters into an arcuate slot 55 in the material of member 1, slot 55 being centred on aperture 52. Not shown in the drawing is a metal reinforcement which is moulded into the exterior of member 1 and which has an aperture registered with aperture 52 and an arcuate slot registered with arcuate slot 55. When member 1 is accordingly assembled on to base plate 41, it can pivot relative thereto, but only to the extent allowed by the travel of tab 54 in slot 55.

If it is desired to restrict the range of rotation of member 1 relative to base plate 41, a suitable stop member may be inserted at one or both ends of slot 55.

Mounted on base plate 41 is a swivel arm 60. The left hand end of this arm as seen in Figure 2 is of ring shape and fitted round a further threaded post formed integrally with base plate 41 and held in place by a screw-in stud 61. The circular left hand end of arm 60 is located in a generally circular recess 62 in base plate 41, the circular wall of which is formed in two sections, one of radius only slightly greater than the

radius of the ring on the left hand end of arm 60 and the other of enlarged radius, the two part cylindrical walls of recess 62 abutting at a shoulder 64 which lies in a radial plane relative to the hidden threaded stud about which arm 60 may swivel. On one side of the generally ring-shaped end of arm 60 is a partial annular flange 66 which, when its end as shown on the left in Figure 2 abuts shoulder 64, limits the clockwise rotation of arm 60. The anti-clockwise rotation is limited by the right hand end of arm 60 as shown in Figure 2 coming to abut an internal wall 68 formed in base member 41. Thus, arm 60 may swivel through a defined angle, which angle may be reduced by inserting packing members against shoulder 64 or wall 68 if it is desired to do so.

Member 2 is pivotally connected to the right hand end of arm 60 by means of a threaded stud 70 which passes through an aperture 71 in member 2 and into a threaded post 72 on the end of arm 60. Arm 60 is formed with an upstanding tab 74 which, when member 2 is assembled on to the arm 60, passes through an arcuate slot 76 in member 2. As with member 1, where of aperture 71 and arcuate slot 76 is prevented by a metal plate set into the side of member 2, not visible in Figure 2. Again, the extent of rotation permitted between arm 60 and member 2 may be reduced by inserting stop members into one or both ends of arcuate slot 76.

The outer periphery of base plate 41 may be contoured so that its inner face lies closely against the exterior faces of members 1 and 2 thus reducing the ingress of dirt or other contamination when the knee brace is worn. The hinge mechanisms 3 and 4 permit natural flexure of the wearer's leg with the three pivotal connections, the

pivot axes of which correspond to the threaded shafts of studs 51, 61 and 70, enabling a natural and comfortable movement to occur. Excessive flexure of the joint, beyond what the wearer's medical or physiotherapist advisors would recommend, may be prevented by restricting the range of angular movement of one, two or all three of these pivotal connections by the use of packing members as indicated above.

## CLAIMS

1. A hinge mechanism for a limb protector including first and second supports each adapted to engage a part of a limb in either side of an articulated joint, the hinge mechanism being pivotally connected to both supports, and wherein the hinge mechanism comprises a base plate, an arm pivotally rotatable against the plate about an axis substantially perpendicular thereto and located to one end of the arm, and means for connecting the support members pivotally to the other end of the arm and to the plate, all of the three axes of rotation of the pivotal connections being substantially parallel, and wherein associated with each of the three pivotal connections are means for restricting the relative degree of rotation of the respective two members to a defined amount.

2. A hinge mechanism according to Claim 1 wherein the arm is mounted rotationally on a circular boss on the plate and the plate has stop means formed thereon restricting the angular rotation of the arm.

3. A hinge mechanism according to Claim 2 wherein the degree of rotation of the arm is limited by locating the arm in a recessed portion of the plate which is bounded by radial walls lined at an angle to one another.

4. A hinge mechanism according to Claim 1, 2 or 3 wherein the angular rotation of each support member relative to the end of the arm or the base plate respectively is restricted by the passage of a stud or post along an arcuate slot centred on the pivot axis.

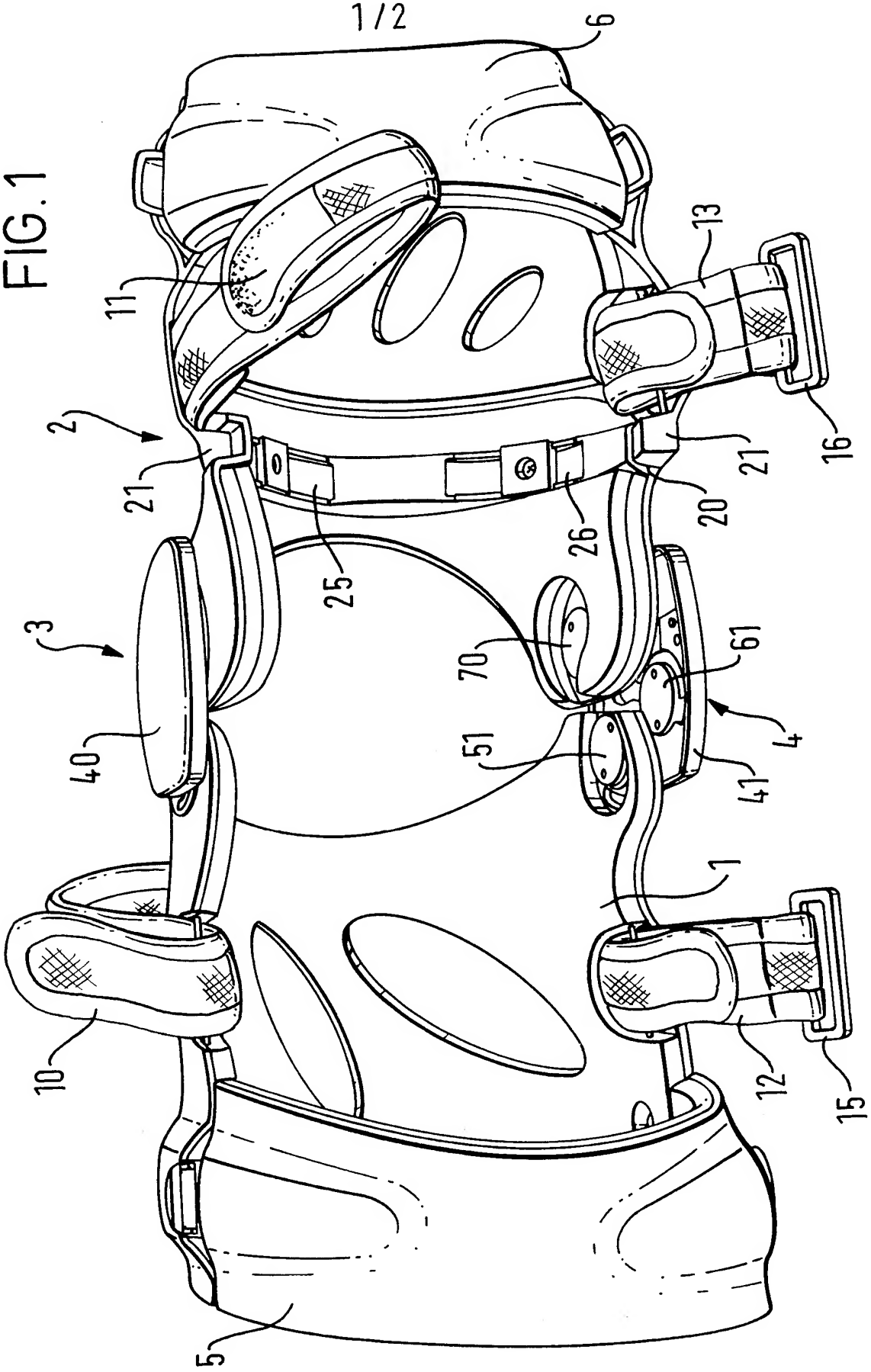
5. A hinge mechanism according to Claim 4 wherein the post is on the base or arm and the arcuate slot in the support member.

6. A hinge mechanism according to Claim 4 or 5 and including one or more spacers inserted into the arcuate slot(s) to limit the degree of rotation by enabling the stud or post to move only along a portion of the arcuate slot(s).

7. A hinge mechanism according to any one of the preceding Claims wherein the support members are made of rigid plastics or fibre reinforced resin type composition and include a metal reinforcement associates with the pivotal connection to the hinge mechanism.

8. A limb protector or brace including a pair of hinge mechanisms according to any one of the preceding Claims.

FIG. 1



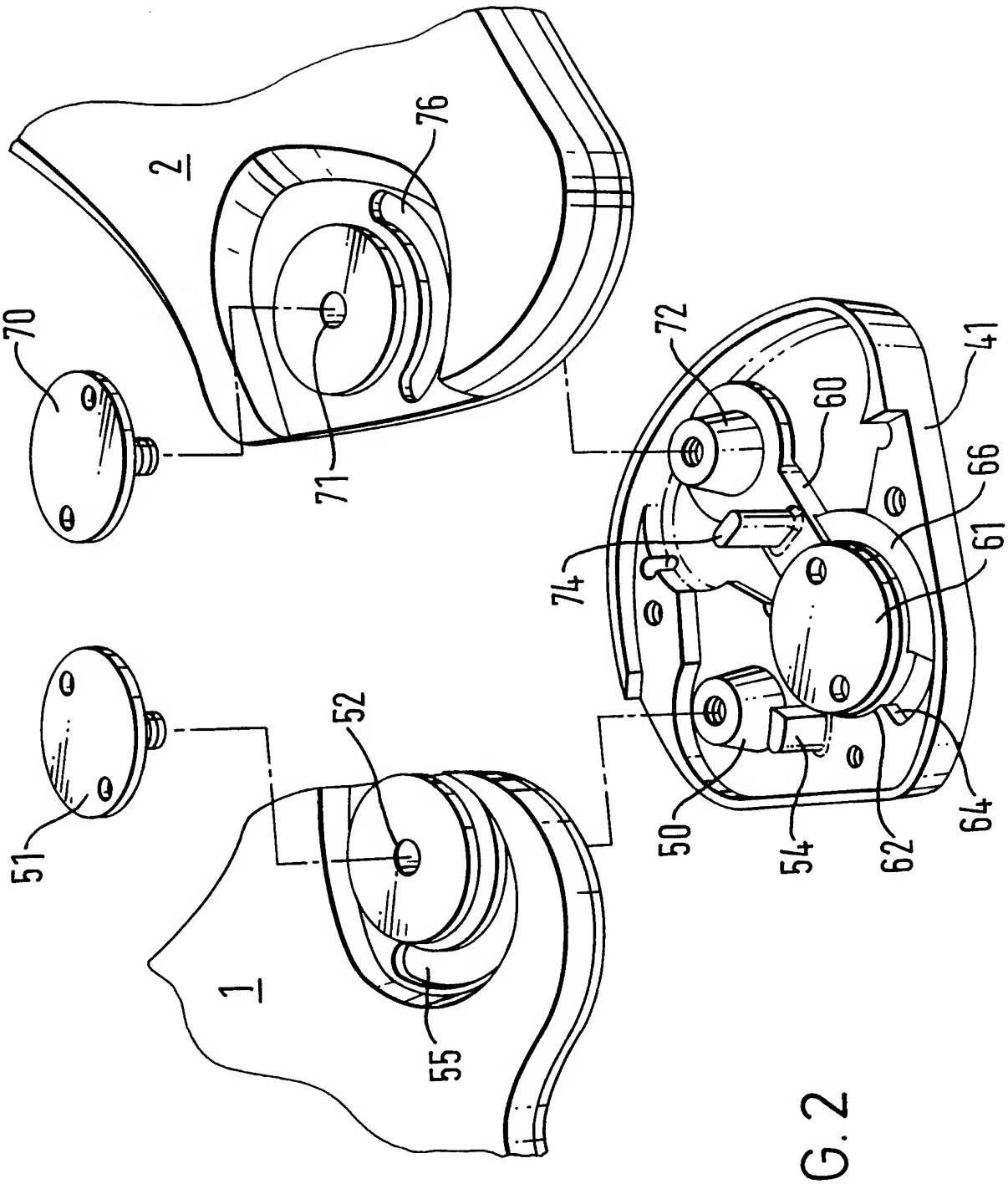



FIG. 2